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CLASSIFICATION OF VARIABLE STARS.

BY SIDNEY D. TOWNLEY.

In 1880 Professor E. C. PICKERING proposed a classification of variable stars as follows:¹

I. Temporary stars. Examples, TYCHO BRAHE's star of 1572, new star in *Corona*, 1866.

II. Stars undergoing great variations in light in periods of several months or years. Examples, α *Ceti* and χ *Cygni*.

III. Stars undergoing slight changes according to laws as yet unknown. Examples, α *Orionis* and α *Cassiopeia*.

IV. Stars whose light is continually varying, but the changes are repeated with great regularity in a period not exceeding a few days. Examples, β *Lyrae* and δ *Cephei*.

V. Stars which every few days undergo for a few hours a remarkable diminution in light, this phenomenon recurring with great regularity. Examples, β *Persei* and S *Cancr*.

This classification is restated, in somewhat different language, in the preface to the *Preliminary Catalogue of Variable Stars*, published by Harvard College Observatory in 1902.² Subdivisions of classes II and IV are suggested, but they are not used in the catalogue nor are they used or mentioned in the *Second Catalogue of Variable Stars*, published in 1906.³

So far as I know, this classification has not been used in any catalogue except those published by Harvard. SCHÖNFELD, CHANDLER, and GORE used no classification in their catalogues.

In the *Catalogue des Etoiles Variables*, issued annually by the Bureau des Longitudes, a classification is used which differs somewhat from PICKERING'S. It is as follows:—

- Type I. Variables of long period.
- Type II. Variables of short period.
- Type III. Variables of *Algol* type.
- Type IV. Variables of antalgol type.
- Type V. Variables of irregular variations.

¹ *Proceedings of the American Academy of Arts and Sciences*, 16, 17, 257.

² *Annals of Harvard College Observatory*, 48, 94.

³ *Annals of Harvard College Observatory*, 55, 1.

In the *Katalog und Ephemeriden veränderlicher Sterne*, published annually in the *Vierteljahrsschrift der Astronomischen Gesellschaft*, no classification is used in the catalogue part, but for convenience of reference four additional parts are given containing the various subdivisions of short-period variables, a term not now altogether applicable. These subdivisions differ from those of the two classifications mentioned chiefly by the fact that stars of the β *Lyræ* type are set off by themselves, a proceeding which is perfectly legitimate for the purposes of an ephemeris.

Mr. A. STANLEY WILLIAMS has recently proposed a new classification which he calls a natural system.¹ The classification is as follows:—

Order I. Binary or compound variables—

- a. *Algol* type, in which the variation is caused by eclipses, but the secondary minimum is either not apparent, or else is small in comparison with the primary minimum.
- b. β *Lyræ* type. Variation caused by eclipses, the secondary minimum being marked and equal, or nearly equal, to the principal minimum.
- c. *Cepheid* type—
 - i. Stars like δ *Cephei*.
 - ii. Stars of the exaggerated δ *Cephei* type of variation, termed “Antalgol” or “cluster type.”
- d. Irregular short-period variables—
 - i. Stars like U *Geminorum*, having some appearance of periodicity.
 - ii. Rapid irregular variables, like RX *Andromedæ*, without definite signs of periodicity.

Order II. Long-period variables—

- a. α *Ceti* type.
- b. Stars like α *Ceti*, but having a pronounced double maximum.
- c. ?

Order III. Irregular variables—

- a. All irregular variables other than rapid irregular variables included under I, d, ii.
- b. *Novæ*.

¹ *The Journal of the British Astronomical Association*, **23**, 133.

Although something may be said in favor of this proposed classification, yet on the other hand there are some points that may be urged against it. Much has been learned in recent years concerning variable stars, but there is perhaps some question as to whether or not we are yet in possession of sufficient knowledge concerning the causes of variation to enable us to work out a "natural" system.

The two fundamental statements upon which WILLIAMS bases his classification are both open to question.

A. "The variability of all eclipse variables and all short-period variables of the δ *Cephei* type is due directly or indirectly to the revolutions of two or more stars around their common center or centers of gravity. In other words, we are in the presence of a binary or multiple system of bodies."

Since the above statement was written, Mr. HAROLD SHAPLEY has published two interesting papers¹ on the variables RU *Camelopardalis*, SZ *Tauri*, and S *Antliæ*, δ *Cephei* or ζ *Geminorum* types of stars, in which he shows that the variation in brightness of these stars can be satisfactorily explained on the hypothesis that they are rotating ellipsoids. If this should prove to be the true explanation, then they are probably not binaries at all and the statement quoted above would not be true.

B. "Variables of long period, like α *Ceti*, are not due to the revolutions of the members of a binary or multiple system of bodies, but the variability is probably inherent in isolated cases."

This may be true, but as Mr. WILLIAMS points out, "only a few long-period variables have had their radial motions investigated by means of the spectroscope," it would seem that further proof of this statement is desirable before it can be used as a basis of a classification of variable stars.

Some further points against the proposed system are as follows:—

1. When it becomes possible to classify variables according to the causes of variation, it will probably be necessary to give up the terms "long-period" and "short-period," yet Mr. WILLIAMS retains both these—one of them, to be sure, only as a sub-head. The variable which has the longest period, ϵ *Aurigæ*,

¹ *Laws Observatory Bulletin*, 2, 71; *Astronomische Nachrichten*, 194, 353.

period 9,905 days, is not a "long-period" variable, but an *Algol* type.

2. Mr. WILLIAMS divides the irregular variables, some being under Order I and some under Order III. The velocity in the line of sight has been determined for but five irregular variables— α *Cassiopeiæ*, α *Orionis*, R *Coronæ*, α *Herculis*, and μ *Cephei*. Two of these prove to be binaries, one probably binary, and two not binary. Surely, this is small evidence upon which to divide irregular variables into binaries and not binaries. It may be of interest to point out that the two binaries, α *Orionis* and μ *Cephei*, and the one probably binary, α *Herculis*, do not show rapid fluctuations of light, and hence, according to WILLIAMS's classification, would *not* be classed as "binary irregular short-period variables," but would fall into the all-inclusive order III *a*. They are binaries, but would not be classed as binaries.

What right have we to classify U *Geminorum* and RX *Andromedæ* as binaries when neither their velocities nor the velocities of any stars of similar fluctuations have been observed?

Can we properly call a system a "natural" one in which it is necessary to provide a "negative" class into which are put all stars that do *not* fall into the other classes? WILLIAMS's Order III *a* is of this kind,—“all irregular variables other than rapid irregular variables included under I, *d*, ii.”

3. WILLIAMS puts *Novæ* under Order III—irregular variables. Is this logical? A phenomenon in order to be either regular or irregular must be repeated. No *Nova* has, so far as known, made more than *one* appearance. These phenomena are all similar, a rapid increase of brightness followed by a more gradual decline, interrupted by minor fluctuations, into a state of former faintness or invisibility. What is irregular about this? If a circus comes to town but once in the lifetime of the oldest inhabitant is that an irregular phenomenon?

4. WILLIAMS has apparently departed as much as possible from the PICKERING classification. For instance, PICKERING put *Novæ* in Class I, while WILLIAMS places them at the end of his classification. Now, there is probably no particular reason why Professor PICKERING should have put *Novæ* first, but so long as he did so would it not be a wise policy, unless

there is some good reason for a change, to stick to that order of classification, with which most of us are familiar?

5. Any system of classification which calls for a division of sub-classes becomes a bit complicated and difficult to memorize.

I venture to suggest that the following modified PICKERING classification will answer all our present needs:—

- I. *Novæ*.
- II. Long-period variables.
- III. Irregular variables.
- IV. Short-period variables.
 - a. δ *Cephei* type.
 - b. ζ *Geminorum* type.
 - c. Cluster or antalgol type.
- V. Eclipse variables.
 - a. *Algol* type.
 - b. β *Lyræ* type.
- VI. Magellanic Cloud variables.

Class II might be divided into sub-classes, perhaps as Mr. WILLIAMS has suggested or perhaps as Professor PICKERING has suggested. There is a fundamental difference between them. Class III could also be subdivided.

If it should be thought desirable to give up the terms "long-period" and "short-period," then Class II might be called "non-uniform-periodic variables" and Class IV "uniform-periodic variables." In this case it would not be necessary to add a sixth class, as the Magellanic Cloud variables would then be put as a sub-class of IV, or perhaps come under the head of cluster type.

The objection to this terminology is obviously that eclipse variables are uniformly periodic, although not classed under that head. Class V might be dropped and put in as a sub-class of IV.